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Automatic Print Removal using Print Head

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Title: Automatic print removal using print head

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Abstract: This publication describes the printing of an extra “helper” structure below and around a print to be removed from the build plate of an FFF printer. The print head can be used to exert a force onto the helper structure so as to loosen the print from the build plate. Once the print is loosened from the plate, it can be pushed to the side and be removed from the build plate. It may then be received by a e.g. a bucket or box placed in front of the FFF printer. The build plate will then be complete empty and can be reused for another print.

Using the print head to bump prints from the build plate has been done before. In order for this to work, the bed adhesion needs to be tuned extremely well. Too much adhesion and it is impossible to remove the print from the bed, too little adhesion means that the print will fail during printing.

We now propose two different methods referred to as the “Scoop method” and the “Jousting method”. In both methods, the helper structure comprises a plate and a ramp connected to the plate.

Scoop method

By printing a specially shaped structure, see Fig. 1, we allow for an easier way for the print head to exert momentum on the print. Since we noticed that once a brim starts to let loose from the build plate it tends to continue, it is important that at least a small part of the brim starts separating from the build plate (at which point it will continue, a bit like peeling Velcro).

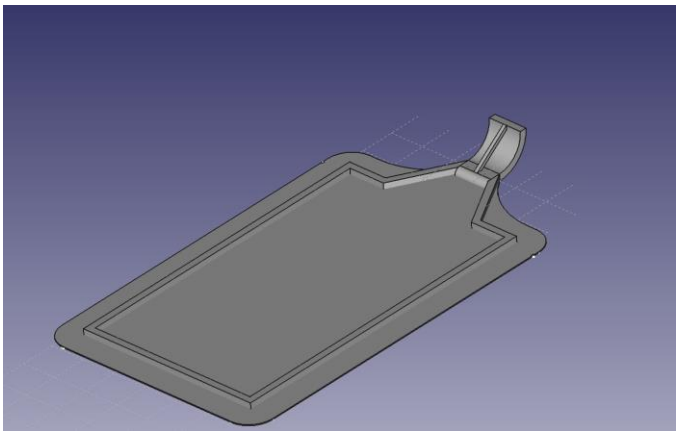

Fig.1

The extra structure around it is to ensure that the force exerted onto the extra shape is transferred nicely onto the rest of the printing.

It might also be that the head shape can be changed in such a way that it works better with the chosen helper structure (e.g. a scoop / bulldozer like shape).

It is noted that the extra structure also makes it easier to manually remove the print, since it provides an easier “handle” for human fingers.

The print head moves against the ramp. This can be either a movement in only the Y direction or a combined movement (both Y and Z at the same time). Our tests have shown that the combined movement results in better separation. This can be explained by the fact that the extra Z move ensures that the force is better directed upwards, creating more of a peeling result.

Fig. 2 shows a further embodiment with a “half pipe” shaped form manufactured on top of the plate. **[please briefly discuss advantages of this one here]**

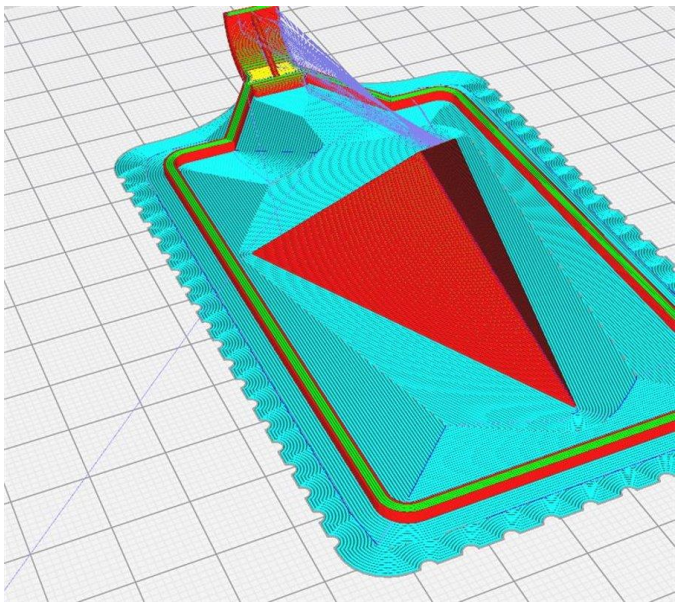

Fig. 2

Jousting method

In this method, the print head is modified to have a small “lance”. The extra helper(s) printed around the object contain rings through which the lance can be poked, see Fig. 3. The print head can then make either a pull motion or a more complicated circular motion (wiggling left /right) to loosen up the object.

Depending on the object, even multiple of these can be printed, each ensuring that a part of the model is loosened before the entire print is removed, see Fig 4. Again, the more a print is loosened before the final “pull”, the greater the chance of successful removal will be.

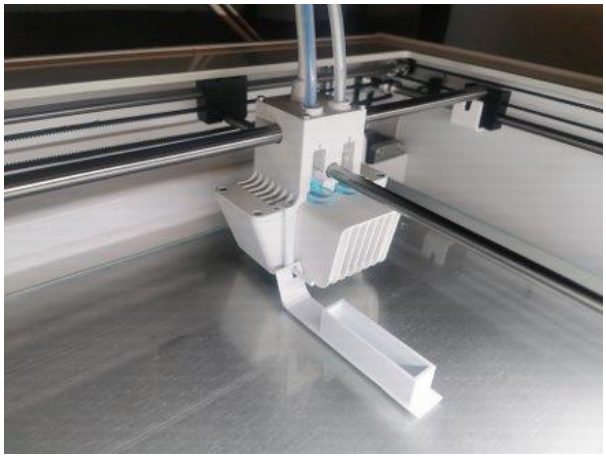

Fig. 3

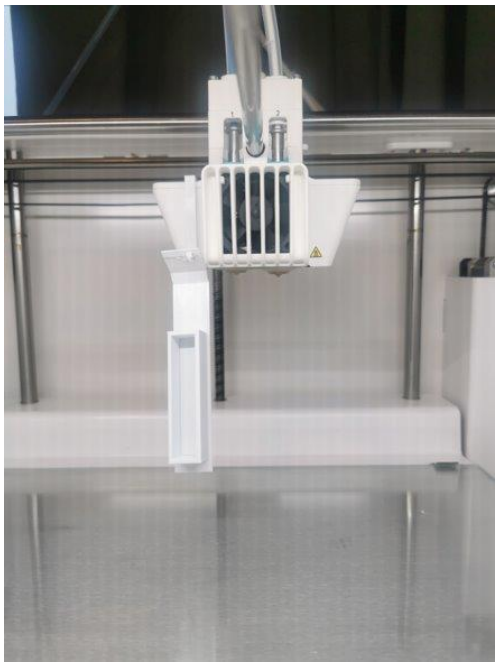

Fig. 4

Figure 3 shows the addon which has been added on the left side (relative to the viewer) of the printhead. The addon contains a “lance”, which is intended to be used as a hook. For that to work, the printed part must be printed on a raft which has an extra ramp with an opening. After the print has finished, the printhead aligns its lance with the opening of the raft’s ramp and starts moving towards the part until the lance is entirely through the opening. Then, the build plate starts moving downwards (or the printhead upwards) so that the raft can be unstuck from the surface, as seen in Figure 4. Note that the build plate has to cool down completely before the extraction process starts, to ensure that the part will unstick from it without issues.

Once the extraction of the part from the build plate has completed, the process of removing the hanging part is initiated. While the part is entirely hanging from the “lance”, the printhead moves to the front of the build plate and stays in place. Then the build plate starts moving up and comes 2-3cm above the center of mass of the hanging part. Then, the printhead starts moving backwards (in the y-direction). This ensures that the hanging part will use the build plate as a “pusher” and, while, the printhead is moving backwards, the part will slide off the lance and fall outside of the printer.

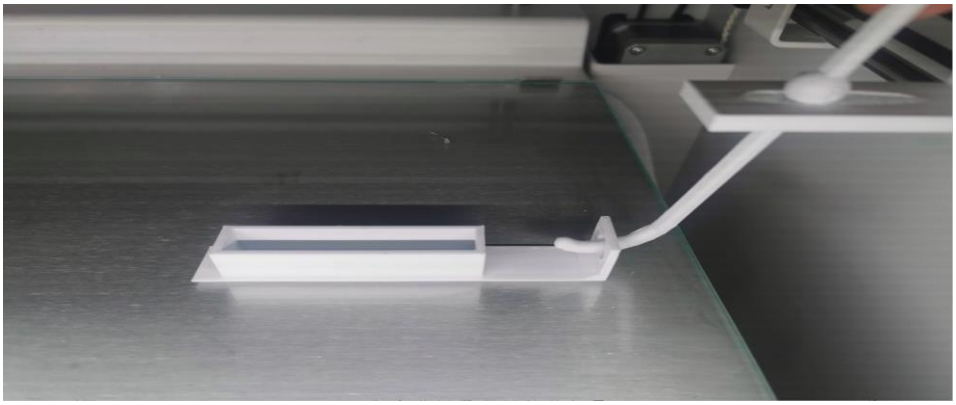

Fig. 5

Figure 5 displays another variation of the same technique, where the hook has been adapted on the side of the printer's frame. In this case, in order for the hook to be moved towards the opening of the raft, there must be a structure that, once pressed by the printhead, will move the hook forward until it is through the opening.